Calculation of AWA drive beam parameters at low charge

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1. Introduction

Due to the requirements about future wakefield measurements on some devices, particular Dave Yu would like use the AWA for wakefield measurement on Maffin Tin structure. It requires low charge but short beam (30 GHz structure). In this note, we calculated the bunch length and the emittance for the drive gun of AWA at different low charge and different bunch transverse size to address these requirements.
As usual, our simulation uses the drive gun (1/2 cell), two standing wave linacs and solenoids. The calculated bunch length and emittance are the parameters at end of the second Linac. The simulated results should be very close to the experiments from the past experience. The initial parameters are shown in Table 1. The input variables are the initial charge and laser spot size. All other parameters are fixed during the AWA operations.

Table 1 The initial parameters used in calculation

Input RF power	1.5 MW
Electric field at gun surface	55 MV/m
Gun injection phase	45^0
Lianc 1 Phase	135^0
Lianc 2 Phase	223^0
Initial electron distribution in transverse section	Normal
Initial electron distribution in longitudinal section	Normal
Solenoid turns	1900 counts
Initial bunch length	4^0
Initial bunch radius (laser spot)	10 mm / 2.5 mm / 0.5 mm
Bunch charge	1 nC / 2 nC / 3 nC / 4 nC / 5 nC

2. Calculation results

Fig. 1 shows the emittance chart for different low charge and different bunch transverse size. Fig. 2 shows the bunch length chart for different low charge and different bunch transverse size.

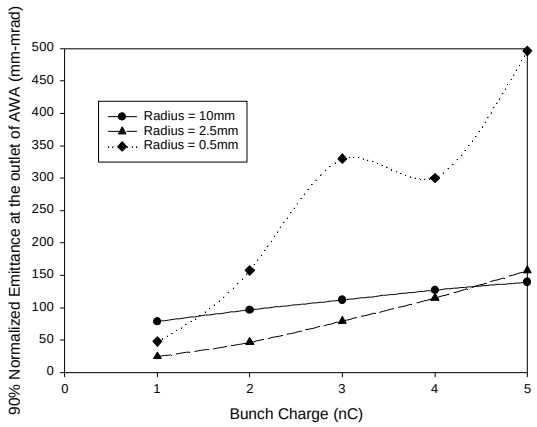

Fig. 1 The emittance chart for different low charge and different bunch transverse size. Some electrons are lost at Bunch Charge = 4 nC and 5 nC under initial bunch radius = 0.5 mm.

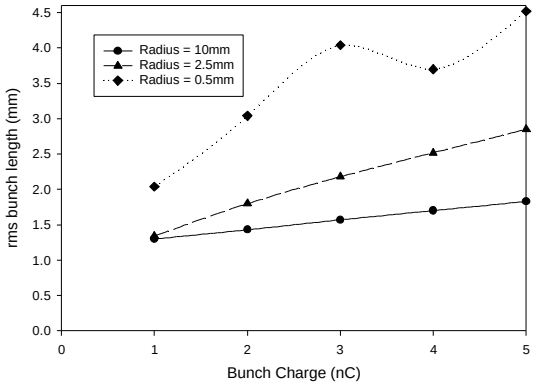

Fig. 2 The bunch length chart for different low charge and different bunch transverse size. Some electrons are lost at Bunch Charge = 4 nC and 5 nC under initial bunch radius = 0.5 mm.

Fig. 3, 4 and 5 show the emittance and bunch length chart for different low charge at initial bunch transverse radius 10 mm, 2.5 mm and 0.5 mm separately.

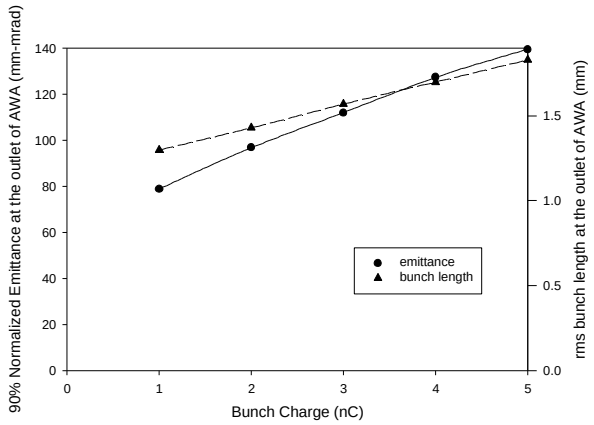

Fig. 3 the emittance and bunch length chart for different charge at initial bunch transverse radius 10 mm.

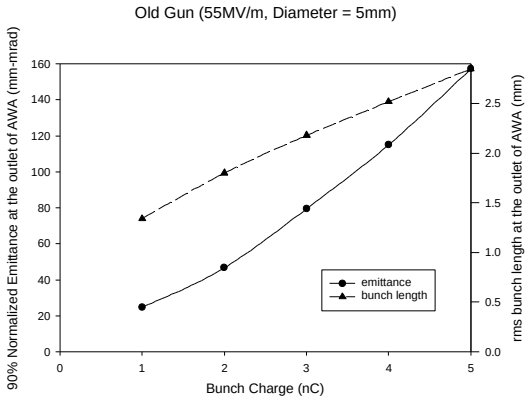

Fig. 4 The emittance and bunch length chart for different charge at initial bunch transverse radius 2.5 mm.

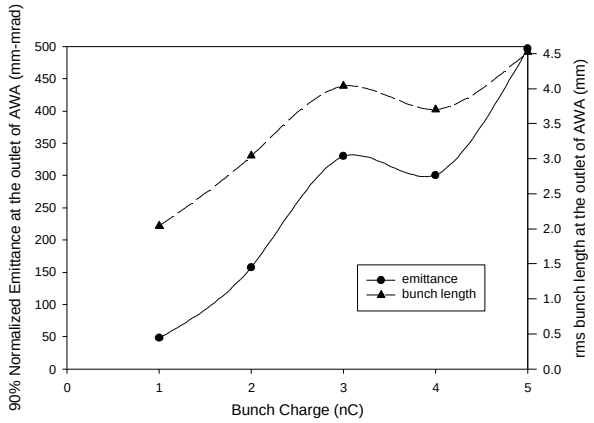

Fig. 5 The emittance and bunch length chart for different charge at initial bunch transverse radius 0.5 mm.Some electrons are lost at Bunch Charge = 4 nC and 5 nC under this condition.

In summary, the best results can be obtained by using 5 mm laser spot size. For 5 nC beam, the rms bunch length would be 1.5 mm which is enough to excite wakefields in 30 GHz structures.